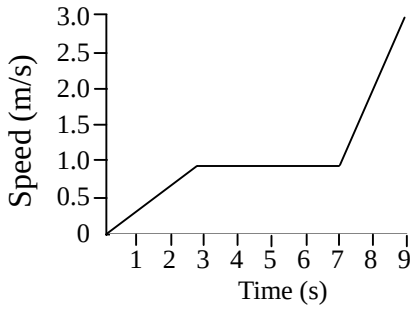
FORCES AND MOTION

As a result of studying the motion of different objects:

Students understand that energy and matter interact through forces that result in changes in the motions of objects.

- *Explain the relationships among distance, time and speed; interpret graphs of motion; and perform calculations using the equation Distance = Speed x Time. (PIIIA1)*

This graph contains information about the motion of a bicycle. At which of the following times is the bicycle's acceleration zero?



a. 1 second
b. 2 seconds
c. 4 seconds
d. 8 seconds

Centuries ago the British physicist Sir Isaac Newton stated three laws that describe the ways in which things move. These are Newton's three laws of motion:

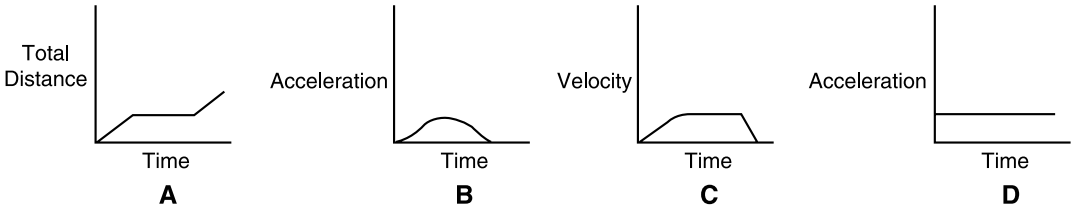
- **The first law:** Unless acted upon by an outside force, a body at rest tends to stay at rest, and a body in motion tends to stay in motion.

- **The second law:** Acceleration is equal to the net force acting on a body divided by its mass.

- **The third law:** For every action force there is an equal and opposite reaction force.

A driver starts her car and steps on the gas pedal. The car gradually accelerates to 50 km/hr. A few minutes later, the driver suddenly slams on the brakes to avoid hitting a box in the road. As the car comes to a stop, the driver's body appears to lurch forward in the seat until it is restrained by the seatbelt.

Use the following graphs to answer the next two questions.



Which graph **best** matches the motion of the car described in the paragraph above?

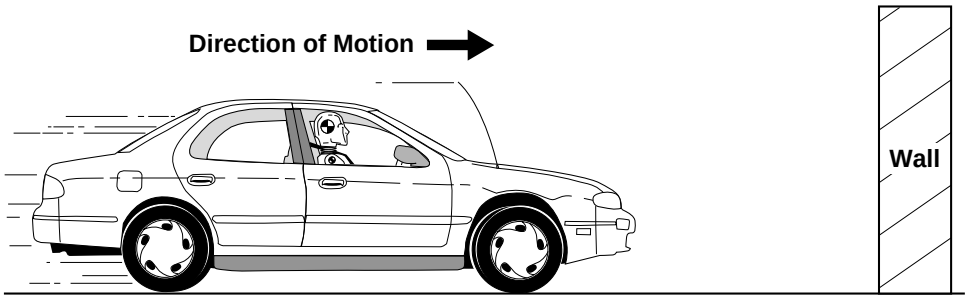
a. A
b. B
c. C
d. D

A student rides her bicycle from her home to the library. She stays there for a while and then goes to a friend's house. Which graph **best** matches this situation?

a. A
b. B
c. C
d. D

- *Describe Newton's three laws of motion, apply them to everyday phenomena, and perform calculations using the equation Force = Mass x Acceleration. (PIIIA2)*

Modern automobiles are tested for collision safety using models of human beings often called crash test dummies. These "dummies" are actually quite "smart." They are often fitted with sensor devices that can record their motion and force of impact during an automobile collision.



When the car accelerates from a standing start, the crash test dummy appears to be pressed backward into the seat cushions. Which of the following **best** explains why this happens?

a. The crash test dummy gets lighter as the car accelerates.
b. The car is moving forward faster than the crash test dummy.
c. There is no reaction to the force of the car taking off.
d. Gravity is pulling the crash test dummy in the direction the car is moving.

A car reaches 80 kilometers per hour, then suddenly crashes into the concrete wall. Without a seat belt, the crash test dummy slams into the car's dashboard because

a. the crash test dummy's kinetic energy drops to zero.
b. the dash is pushed backwards into the crash test dummy.
c. the momentum of the car is being transferred to the crash test dummy.
d. the car has stopped, but the crash test dummy is still moving forward.

This test paper is sitting at rest on your desk. Which of the following statements best describes this situation?

a. There are no forces acting on your paper.
b. Your paper is at rest in any coordinate system.
c. Your paper exerts no force on the desk.
d. There are several forces acting on your paper, but they balance each other.

- ***Describe the effects of gravitation on the motion and weight of masses. (PIIIA3)***

The moon has a smaller mass than the Earth. If you were able to travel to the moon your weight would

a. increase.
b. descrease.
c. remain the same.
d. vary from day to night.

If you were able to go to the top of a tall building and simultaneously drop an apple and a basketball, they would both hit the gound at about the same instant because

a. the force of gravity on them is equal.
b. they have the same mass.
c. air resistance on both is the same.
d. they have the same amount of kinetic energy.

Students understand the nature of electricity and magnetism.

- *Describe the factors that affect the electrical forces between charges and explain how electric currents and magnets exert a force on each other. (PIIIB1)*

A balloon is rubbed with a piece of cloth. As a result, the balloon has a negative charge. What has happened?

a. Electrons have moved from the inside to the outside of the balloon.
b. Positive charges have traveled from the balloon to the cloth.
c. Electrons have moved from the balloon to the cloth.
d. Electrons have traveled from the cloth to the balloon.

Static electricity happens when electrons pass from one object to another, such as from your hair to a comb as you comb your hair. If you then hold the comb near your hair, strands of hair appear to move forward and "stick to the comb." The hair and the comb

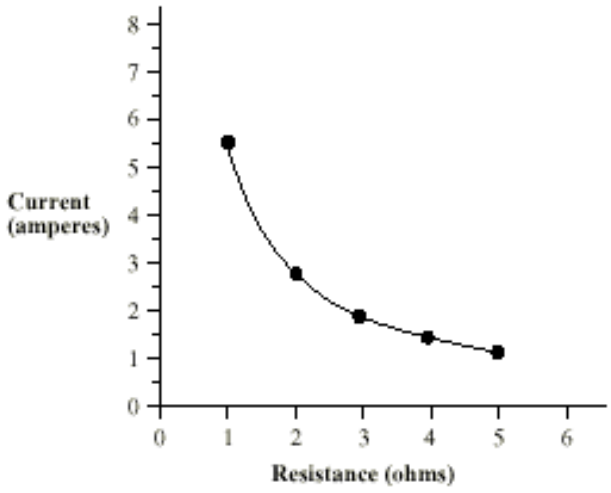
a. attract each other because they have the same charges.
b. attract each other because they have opposite charges.
c. repel each other because they have the same charges.
d. repel each other because they have opposite charges.

- ***Describe the effects of voltage and resistance on the flow of electric charges in a series circuit. (PIIIB2)***

To double the current through a resistor in a circuit,

a. double the voltage across the resistor.
b. double the resistance of the resistor.
c. double the voltage across the resistor and double the resistance.
d. double the resistance and decrease the voltage across it by half.

Jeff used a multimeter to test the current and resistance of a variable resistor and plotted the results on the graph below.



The graph shows that current

a. increases when resistance decreases.
b. decreases when resistance decreases.
c. increases when resistance increases.
d. doubles when resistance increases.

As a result of studying various forms of energy:

Students understand the nature of various forms of energy.

- ***Describe various forms of energy including light, heat, chemical, electrical and mechanical energy and identify them in various physical settings. (PIVA1)***

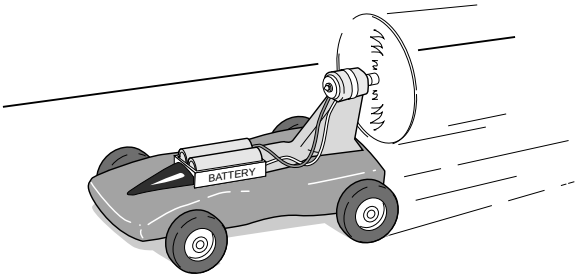
When operating, ordinary incandescent light bulbs produce a lot of heat in addition to light. Fluorescent light bulbs produce much less heat when operating.

If you wanted to conserve electricity, which type of bulb should you use? Explain your answer.

Coal is burned in a power plant that produces electricity. In a house miles away, a light bulb is turned on. Describe the energy transformations involved.

- ***Describe kinetic and potential energy transformations in biological, chemical, mechanical and electrical systems. (PIVA2)***

Toy Car



What energy transformations and forces influence this battery-powered toy car? Explain your answer fully.

Windmills are used to convert wind energy into a more useful form. In most cases, there are three steps in this process. The energy is in a different form at each step. Which of the following flowcharts shows the most likely order of the energy changes?

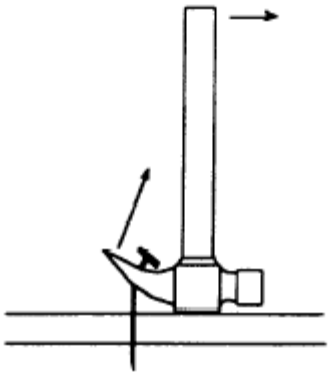
a. wind energy --> mechanical energy --> solar energy
b. wind energy --> thermal energy --> mechanical energy
c. wind energy --> solar energy --> electrical energy
d. wind energy --> mechanical energy --> electrical energy

- ***Describe simple machines, including ramps, levers and pulleys, and explain their use in terms of work and forces. (PIVA3)***

A bicycle is a composite of several simple machines. Describe where these simple machines are found on a bicycle: lever and pulley.

Which of the following objects acts as a lever when pulling a nail?

a. hammer
b. head of nail
c. board
d. point of nail



Students understand the properties of sound and light.

Describe different classifications within the electromagnetic spectrum in terms of their wavelengths, energies, effects on living organisms, and uses in modern technologies. (PIVB1)

Which of the following aspects of electromagnetic radiation best explains why electromagnetic radiation is both useful and harmful to humans?

a. Electromagnetic radiation travels at the speed of light.
b. Electromagnetic radiation can travel through a vacuum.
c. Electromagnetic radiation is energy and can interact with matter.
d. Electromagnetic radiation can be described in terms of both wavelength and frequency.

- ***Describe the wave properties of sound, including volume and pitch. (PIVB2)***

(no examples provided)

- ***Explain the behavior of light, including reflection, refraction, absorption.and the phenomenon of color. (PIVB3)***

Raul's little sister, Sarah, wants to know why she can see herself in a mirror, but she can see through a window. What should Raul tell his sister to explain the differences between mirrors and windows?

Which of the following choices best explains why grass on a distant hillside appears green?

a. Grass reflects all colors except green.
b. Grass absorbs only green light from the sun.
c. Grass reflects green light more than any other color.
f. Grass transmits green light in the same way that green-colored cellophane does.

The setting sun often appears red. What is the best explanation for this?

a. The surface temperature of the sun is lower at sunset than at other times of the day.
b. The Earth's atmosphere scatters blue light, so that at the Earth's surface mostly red light is visible at sunset.
c. The path of light through the Earth's atmosphere is shorter at sunset than at noon.
d. The surface of the Earth changes infrared radiation into red light.